ANNUAL REPORT

LAKE STATES FOREST EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

E. L. DEMMON, DIRECTOR

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MAINTAINED IN COOPERATION WITH
UNIVERSITY OF MINNESOTA
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INTRODUCTION

As the clouds of war again darken the horizon, our Nation once more is faced with tremendous demands upon its natural resources, seriously depleted in the last emergency. Following a slight lull after the close of World War II, the demand for forest products now is increasing. Already there are signs of paper shortages and reduced supplies of lumber. Again there is need to step up wood production, but we should be on guard against further impairment of our forest resources. This calls for all the skill and knowledge that foresters possess, and cooperation from landowners, industry, farmers, legislatures, and the general public. It will call for more, rather than less, research -- with the results quickly translated into improved practices.

Forestry, like industry, must be based on periodic and accurate stock taking. Unless we know the size and condition of our resource, we cannot plan its management wisely. For this reason the Forest Survey of the Lake States, now under way in cooperation with other public and private organizations, is of great importance. Although only about one-third done, this survey, in combination with one completed in 1937, shows that the 50 million acres of forest in the Lake States are producing only about half of the region's present timber needs, but that they could meet local timber needs fully, if better forestry were practiced.

To work out better forestry practices is the main purpose of the Station's research program. Aside from the Forest Survey and some economic and farm forestry studies, most of the field work is located on experimental forests and is directed from local offices known as research centers. Studies on how to cut, reproduce, and increase the growth of pine, northern hardwoods, black spruce, and other forest types, and how to seed and plant new forests are conducted at research centers in northern Minnesota, northern Wisconsin, the Upper Peninsula of Michigan, and the Lower Peninsula of Michigan. No research center has yet been established in the Upper Mississippi Woodlands area of southern Minnesota and southern Wisconsin, where the Station also is responsible for carrying the federal share of forest research.

U.S.D.A. - S.C.S. Milwaukee, Wis. 1951

Better utilization of forest products also is urgently needed, both to make the present resource go farther and also to realize the full productivity of the land. But the Lake States region remains the only important forest region in the country not yet provided with a forest utilization service unit. This is so despite the fact that the Station is receiving an ever-increasing number of requests for help in this field. A forest utilization service unit would provide a connecting link between the Forest Products Laboratory at Madison, Wisconsin, and the forest products industries and other timber growers and users in the field. Its primary functions would be to seek out wood-using problems of the region, channel them to qualified research agencies, and bring the best up-to-date knowledge to the industries, wood users, and timber growers.

Plans for 1951 must be adapted to the changing national situation. To avoid interrupting vitally important long-range investigations, staff workers must perform with unusual efficiency, must cut corners to offset constantly increasing costs of operation, and must provide time to handle special emergency projects when required. It is likely that short-time emergency studies related to production of critically needed materials will become more and more frequent.

With current unsettled conditions in mind, the annual report of the Lake States Forest Experiment Station for 1950 points out Station findings which when applied can result in better handling of the forests of Minnesota, Wisconsin, and Michigan, and thus contribute to national security. How much forest we have, its growth, the drain upon it from cutting and natural losses, better cutting methods for hardwood, spruce, and pine forests; how to regenerate aspen lands, improved management of pine plantations, more efficient fire protection methods, more economical farm forestry -- all these are discussed in the pages which follow.

FOREST ECONOMICS

The inventory of forest resources, special studies of key wood-using industries, cooperation in emergency production studies, and the financial aspects of forest management are the principal studies under way in the field of forest economics.

The Lake States' Forest Resources

The three Lake States of Minnesota, Wisconsin, and Michigan, which are heavy importers of timber, can meet all their needs for forest products if they carry out a long-range forest improvement program, according to a recently published report[1/] which summarizes several resource

1/ "Forest Resources of the Lake States Region" by R. N. Cunningham and the Forest Survey staff of the Lake States Forest Experiment Station. U.S.D.A. Forest Resources Report No. 1, 57 pp., illus., 1950.

surveys made during the last 15 years. The report shows that the Lake States, severely cut-over in past years, could increase current timber growth 25 percent on forest areas by improved management and better utilization. It is estimated that total timber production of the ares could be doubled in 70 years.

The situation is described as follows:

1. Large acreages of young growth on the 50 million acres of forest and woodland in the three statss have reached a stage where they will respond readily to improved care. Some forest areas are badly run down, but they are gradually becoming restocked as a result of improved fire protection and the extension of better management practices.

2. Despite these recent gains, the Lake States are still compelled to import more than half their sawn timber from other regions. They get pulpwood from Canada and the Rocky Moutains. They import utility poles, boxboards, and railroad ties from out-of-state sources.

3. The pulp and paper industry of the Lake States has grown tremendously. Based on 1947 figures, a total of 101 paper mills and 46 pulp mills are operating in the three states. Pulpwood consumption has increased from less than one-half million cords in 1904 to 2.8 million cords in 1948. Paper mills turned out 3.8 million tons of paper and board in 1947, approximately 18 percent of the national total.

4. Annual timber consumption in the three states is estimated at 980 million cubic feet as compared with an output of timber products of only 675 million cubic feet, which indicates heavy dependency on outside sources. For saw timber alone, the annual consumption is 3 billion board feet, with only one-half this amount being produced in the Lake States.

5. A deficit in growth of saw timber amounting to one-fourth billion board feet annually is the most urgent forest problem in the region. The volume of trees of sawlog size has been declining sharply in quantity and quality for several decades. In some places, premature cutting of trees and clear cutting are still practiced to the detriment of the region's forests.

To build larger future yields of timber and at the same time provide as much essential raw material for existing industries as is feasible, the following program is needed:

1. Practice better forestry in existing stands immediately.

2. Plant at least 100,000 acres of nonrestocking land each year.

3. Give the forests adequate protection from fire and also from insects, disease, and animals.

4. Substitute surplus species for scarce species in wood-using industries.

5. Develop coordinated plans for sustained yields of timber, and stabilize forest ownership.

Focusing Forest Survey on Most Urgent Problems

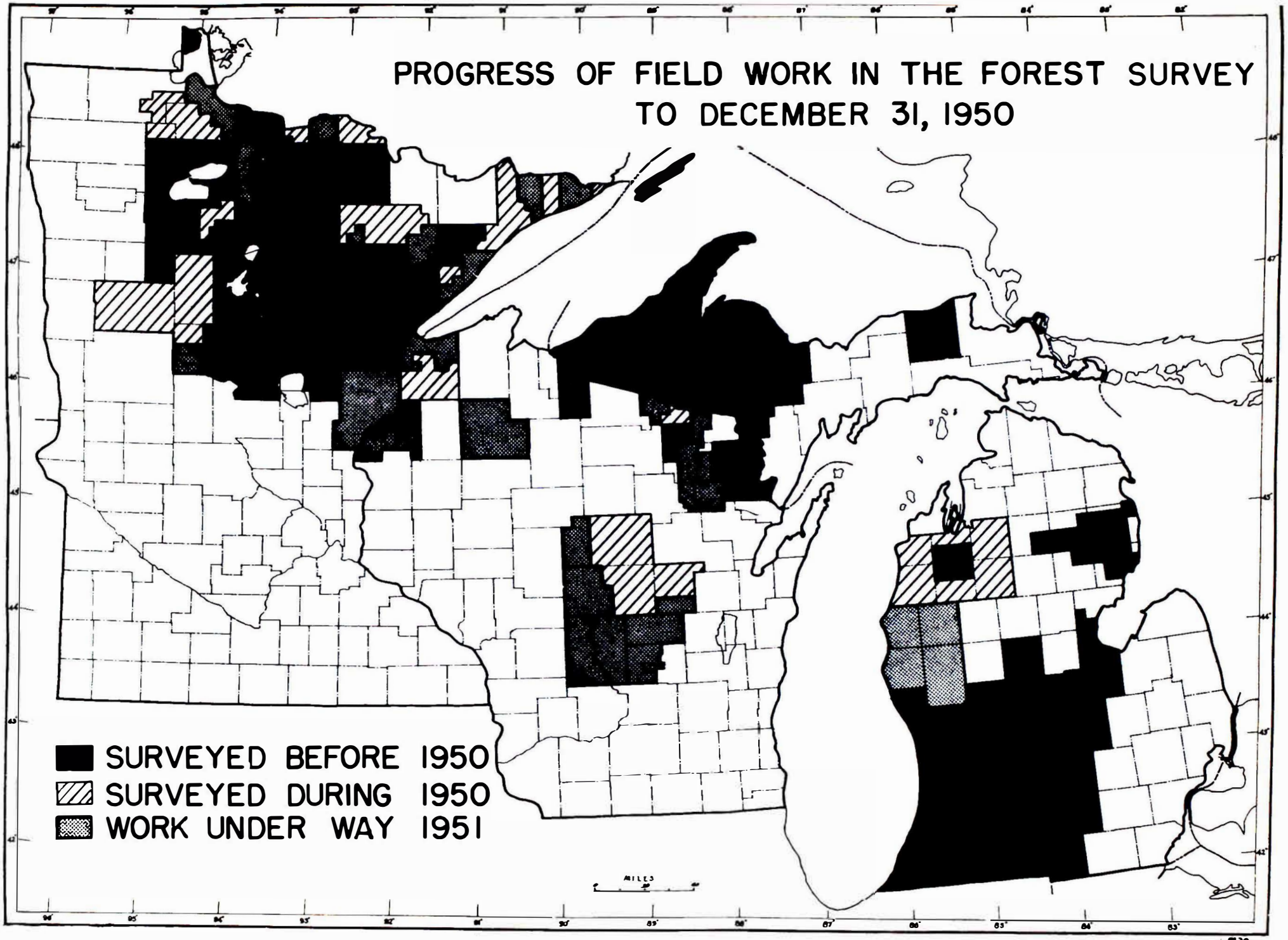
One of the first requirements for planning constructive forest management and wood-using industry developments is an inventory of land and timber. Such an inventory is no less essential in times of emergency than in times of peace. Since 1934, the Station has attempted to maintain a survey planning organization and a clearing house for region-wide statistics on forest areas, timber volumes, annual growth, and annual drain for forest lands in all ownerships. Since 1946 it has been spear-heading a cooperative project to obtain good aerial photographs and accurate up-to-date timber inventories for most of the forested counties in the region. The Station believes that it will be effort well spent to complete the cooperative surveys now under way, to find out what supplies of veneer timber, saw timber, pulp timber, etc., are available to processing plants now and what additional volumes can be expected in the next 20 years. It will require approximately five years at the present rate to finish the inventory and report on results. The plan of survey should be kept flexible so that special defense needs can be accommodated.

New Minnesota Inventory About 44-Percent Completed

Active survey work is being done by a number of agencies under a coordinated plan designed to yield a complete state inventory by 1955. On December 31, 1950, the field work was about 60-percent done and reports had been issued for 6 counties -- Crow Wing, Aitkin, Itasca, Clearwater, Carlton, and Cass (at printers). Approximately 44 percent of all work planned had been completed.

The Chippewa National Forest has completed all field work for its 1-million-acre area and is in process of preparing detailed management plans based upon the new maps and figures. The Superior National Forest, with a 4- to 5-man crew, has finished mapping about two-thirds of the 2-million-acre forest and has taken about one-ninth of the sample plots planned.

The Office of Indian Affairs has largely completed mapping and inventorying the Red Lake Indian Forest and is considering some similar operation on the valuable Nett Lake Reservation.


PROGRESS OF FIELD WORK IN THE FOREST SURVEY
TO DECEMBER 31, 1950
SURVEYED BEFORE 1950
SURVEYED DURING 1950
WORK UNDER WAY 1951
MILES

The Division of Forestry, Minnesota Department of Conservation, completed its survey of the Pine Island State Forest and is cooperating on sampling the remainder of Lake of the Woods County.

The Office of Iron Range Resources and Rehabilitation continued to take the lead in sampling forest areas outside of federal and state forests in the northern part of the state. After completing Beltrami and Cass Counties, its foresters have extended field work into Hubbard, Wadena, and Becker. At the same time, they have cooperated with eight counties in making detailed inventories and cutting budgets for tax-forfeited lands administered by the counties. The Iron Range Office has been publishing the County Reports.

The Station has assisted all of the above agencies in planning the inventory methods, computing growth and allowable cut, and estimating drain.

Plans have been under consideration for extensive surveys in the wood lot and prairie sections of the state, but no actual survey work has been done yet.

Michigan Survey One-Third Done

During the past year, a small crew with personnel from the Station, the Michigan Department of Conservation, and the American Box Board Company completed the field work for Manistee, Wexford, Missaukee, Kalkaska, Grand Traverse, and Benzie Counties in the Lower Peninsula.

Maps and inventories for the Huron and Ottawa National Forests were completed but work has not yet been started on the Upper Michigan and Manistee Forests.

Altogether, field work is 49-percent done; the entire survey job, about 33-percent done.

New Survey Started in Wisconsin

In cooperation with PMA, contracts were let for 8,800 square miles of new air photos (mostly infrared). The State Department of Conservation engaged a crew of 23 foresters starting July 10. These survey men are to be paid from a cooperative fund to which the state, the counties, and forest industries contribute.

By December 31, the field crews had covered Marathon, Portage, Waupaca, and part of Douglas Counties. Delays in getting approved photographs retarded progress in other areas.

Plans have been developed for a survey of forest industries and timber drain during the next few months.

Studying Requirements of Key Forest Industries

During World War II the Station was called upon repeatedly to advise the War Production Board, the Office of Price Administration, and War Manpower agencies with respect to conditions and needs in forest industries. So as to be well prepared to provide similar technical assistance on short notice in the future, the Station proposes to establish additional working relationships with federal, state, and county foresters and with key men in the various industries.

The Pulp and Paper Industry

Pulp and paper played an important role in the last war and doubtless will be equally important in the future. The Division of Economics at the Station has an active project of collecting and analyzing facts relative to the wood supply situation in this industry. While not yet completed, the study has brought out these points:

1. The industry in this region reflects two basic national trends: a per-capita consumption of paper and allied products that has increased steadily with only a few disruptions due to war, and a total population that has continued to increase dospite predictions to the contrary. These two trends produced an annual increase in demand of more than 4 percent over the past decade. The long-run growth of the Lake States pulp and paper industry, therefore, is limited more by its ability to produce at prices competitive with the industry in other regions than by markets.

2. Domestic spruce and hemlock pulpwood supplies are low, while Canadian restrictions on exports of pulpwood have affected supplies from that source. However, the Lake States industry should be encouraged by the fact that second-growth balsam fir supplies are increasing and will help tide it over until second-growth spruce reach merchantable size. In any case, it is probable that softwood pulping species will continue to be in short supply for some time to come, and the industry must make adjustments to that fact.

3. Sulphate and semichemical pulping of hardwoods is increasing rapidly. Demand for hardwoods for pulping has increased to a point where more specific information on present and prospective hardwood pulping supplies is needed. Such information is vital to the industry in planning its wood needs.

However, accurate information on wood supplies must await completion of the Forest Survey in this region.

Other Industries

Veneer and plywood, especially high-grade birch veneer, are forest products of unusual importance in time of war. Preliminary studies of the industry are planned for 1951.

Many items, which in normal times are made of metal or imported woods, may have to be constructed from Lake States timber in the interest of conserving critical materials, railroad space, and industrial manpower. Judging from past experience, these may include such things as food containers, truck bodies, office furniture, toys, fuel and fence posts. Availability of suitable wood and manufacturing facilities, therefore, are important. Facilities for expanded production of many of these items can be found in the thousands of small mills scattered throughout the region. There may be need in the near future to make periodic contacts with these potential producers on a scientific sampling basis.

Financial Aspects of Forest Management

The Station is systematically assembling information on costs and returns from carrying on specific forest practices in certain ways for use of forest owners and managers concerned with the business aspects of growing and harvesting timber.

A study in Lower Michigan in 1950 showed that a farmer selling logs from his wood lot at the roadside was able to obtain twice as large a net return (for profit, risk, and interest) on his wood-lot investment as he would have received from selling stumpage alone. This net return was in addition to his wages for doing the logging computed at $1 per hour.

In northern Wisconsin a small mill operator was able to profit from sawing "cull" as well as merchantable logs of yellow birch. In this case, 959 birch and maple logs (861 merchantable, 53 submerchantable in size, and 45 culls) from an improvement cutting in second-growth hardwoods, containing a remnant of old trees from the original stand, were run through a circular sawmill in 1949 with the following results: Merchantable yellow birch logs yielded lumber worth approximately $92 per thousand board feet (lumber tally). Deducting stumpage value of timber — about $27 per M (lumber tally) in this instance -- the operator obtained about $65 per M for logging and milling. From the yellow birch cull logs, which because of hollow centers, open frost cracks, or other serious defects, were not scaled and thus carried no stumpage cost, he obtained lumber worth approximately $91.50. In spite of somewhat higher logging and milling costs on the cull logs, their utilization appeared to be profitable. In the case of the sugar maple culls, the decision was closer because this species has a lower stumpage value and it produced lumber worth about 20 percent less than birch. Also, the milling of the unusually small logs was a marginal proposition inasmuch as the average value of the lumber cut was but $45 in the case of birch and $47 in maple.

FOREST MANAGEMENT

How to harvest timber, how to mold developing stands, how to restore forest to denuded areas -- these are subjects of current research to improve forest practices.

Laying Groundwork for Improved Silviculture

Among the studies made in 1950, those on chemical brush control yielded results of most immediate practical value. Other useful findings concerned jack pine management, effects of thinning on red pine growth, and improvement cuttings and post-logging damage in second-growth northern hardwoods.

Chemical Control of Woody Plants

Findings in 1950 gave a firmer basis to the promising results of the previous three years in killing undesirable woody growth with chemical sprays. An evaluation of alder control tests made two and three years previously in northern Wisconsin showed that 90+-percent elimination of this species could be obtained (1) by foliage sprays of mature alder with the isopropyl ester of 2,4,5-T at a concentration of 2,150 p.p.m. in water and a rate of 100 gallons per acre, or (2) by swabbing freshly cut stumps with ammonium sulfamate at a concentration of 2 pounds per gallon of water. Costs were about $12.50 and $25 per acre for the two treatments respectively. Sprouts 3 months old were successfully controlled by foliage sprays of the isopropyl ester of 2,4-D at a concentration of 3,380 p.p.m. in water applied at the rate of 29 gallons per acre. Treatment, including cutting, cost about $27.50 per acre.

A study was made in Lower Michigan in which white pine and red pine were released from overtopping aspen, red maple, and oaks (northern red, black, northern pin, and white) by several methods at different seasons. Chemicals gave first-season kills ranging from 83 percent for white oak to 100 percent for aspen when applied in winter, spring, or summer. Comparative costs are given in the table on the next page.

A damaging effect that needs further investigation was noted in Lower Michigan, in that 12 to 40 red pines per acre in two different plantations died in the vicinity of clumps of aspen that had been treated with ammonium sulfamate crystals during the spring.

To be of practical use chemical herbicides must be not only effective but also relatively cheap to apply; so recent studies in northern Minnesota have been aimed at determining the minimum effective rate per acre. Results during 1950 showed that kills of hazel brush were as good with 40 to 60 gallons per acre of hormone herbicides (2,4-D; 2,4,5-T; and combinations of the two) as with 80 to 150 gallons in concentrations of 2,500 to 5,000 parts per million.

Release method	Per acre							Per sq.ft. B.A.	
	Basal area	Trees	D.b.h. avg. tree	Man-hours 1/	Quantity used: Chemical	Oil	Total	Man-hours	Herbicide
	Sq.ft.	No.	Inches	Hours	Amount	Gals.	Amount	Hours	Amount
Conventional axe method 2/	37.49	549	3.5	7.8	0	0	0	0.208	0
Ammate crystals 3/	38.42	545	3.6	10.4	25.12 lbs.	0	25.12 lbs.	0.271	0.654 lbs.
2% Esteron 44 4/ in oil	39.48	625	3.4	5.5	.40 gal.	19.72	20.12 gals.	0.139	0.510 gals.
2% Esteron 245 5/ in oil	39.52	607	3.5	4.8	.37 gal.	17.94	18.31 gals.	0.121	0.463 gals.
2% Esteron Brush Killer 6/ in oil	41.12	605	3.5	4.9	.38 gal.	18.86	19.24 gals.	0.119	0.468 gals.
4% Esteron Brush Killer 6/ in oil	40.44	554	3.7	5.8	.83 gal.	19.87	20.70 gals.	0.143	0.512 gals.

1/ Labor cost of basal sprays can be cut in half if only lower 12 to 18 inches of stem is treated.

2/ Trees less than 4 to 5 inches d.b.h. were cut and the larger ones girdled.

3/ Trees less than 3 to 4 inches d.b.h. were usually cut and notches or cups made at the base of the larger trees.

4/ Esteron 44 with acid equivalent of 2,4-Dichlorophonoxyacetic acid of 43 percent or 4 pounds per gallon, applied as spray to lower 4 feet of stem.

5/ Esteron 245 with acid equivalent of 2,4,5-Trichlorophenoxlyacetic acid of 43 percent or 4 pounds per gallon, applied as spray to lower 4 feet of stem.

6/ Esteron Brush Killer contains a 50/50 mixture of Esteron 44 and 245, applied as spray to lower 4 feet of stem.

Increasing the Yield of Jack Pine Stands

With the increasing use of jack pine for pulpwood, sawlogs, poles, and fence posts, there is need for intensive management of jack pine stands to obtain larger yields. An example of how yields from jack pine in Lower Michigan could have been increased is illustrated by a 49-year-old stand on a poor to medium site in which net growth for the last 10-year period was 4½ cords per acre. However, trees that died during this same period amounted to 3 cords per acre. Thus, total yield could have been almost doubled if frequent light salvage cuttings had been made.

Damage to the Understory Caused by Felling Large Cull Trees

What should be done about large cull trees, remnants of the original stand, that occur in second-growth northern hardwoods? They obviously hinder growth of younger and better trees beneath them. One way of getting rid of culls is to fell them, but this damages the understory. The amount of such damage was determined during an improvement cut in second-growth hardwoods on the Argonne Experimental Forest in Wisconsin.

A detailed study was made of the effects of felling cull trees averaging 25 inches in diameter at breast height, 67 feet in height, 27 feet in crown diameter, and 36 feet in crown length. For each cull felled, 1½ trees were damaged beyond recovery and 3½ trees were damaged less severely. Considering only the understory trees 5 inches d.b.h. and larger, each cull felled damaged 2½ trees or 1.04 square feet of basal area.

If the above figures are applied to the entire stand, it is found that about 12 trees or 5.0 square feet of basal area per acre would be damaged. This amounts to 6.6 percent of the stems or 6.0 percent of the total basal area of trees 5 inches and over in diameter.

Since the loss is among trees badly needed for future growth, it appears that some other method of cull removal such as girdling or poisoning might be preferable. Girdled trees, for example, die slowly. Tops rot first and the branches come down in pieces. Finally the main stem falls. Thus, the damage to smaller trees is decreased.

Partial Cuts in Aspen-Balsam Fir Type Prove Economically Feasible

In the northern Lake States there are extensive areas of aspen stands with an understory of balsam fir. Some light on how to handle such stands was shed by a series of cuttings made in 36-year-old aspen (medium to good site) over balsam fir. Among the cutting methods tried, the following, involving partial removal of 4 to 8 cords per acre from the overstory, proved economically feasible: (1) removal of all aspen containing three 100-inch bolts to a 4-inch top diameter; (2) removal of all aspen containing two such bolts.

Improvement Cuts Reduce Windstorm Loss in Second-Growth Hardwoods

That proper partial cuttings in second-growth hardwood stands improve windfirmness was illustrated by a moderate improvement cut made in the spring of 1949 on the Argonne Experimental Forest in northeastern Wisconsin. About one-third of the merchantable sawlog volume (trees over 10 inches d.b.h.) was removed in the form of high risk, mature, overmature, forked, leaning, or otherwise defective trees. In October 1949, one of the most severe windstorms on record swept the area, but volume losses on the partially cut area were only one-seventh those on adjacent uncut stands.

Growth of Red Pine Improved by Thinning

Height growth as well as diameter growth of red pine can be improved by thinning according to studies made in Lower Michigan in cooperation with the Michigan Conservation Department. Thinnings were made in a well-stocked 27-year-old plantation and in an overstocked 43-year-old natural stand in 1939. Both stands were on sites slightly below medium for red pine. The succeeding ten years' height growth is shown in the following table:

Crown class	Natural stand		Plantation	
	Thinned	Unthinned	Thinned	Unthinned
	Feet			
Dominant and codominant trees	11.0	8.9	11.6	10.9
Intermediate trees	8.7	5.4	....	9.9

Cooperating with Industry for Better Forestry

Following completion of the successful cooperative study of balsam fir yields in 1950, a meeting was held at which representatives of the Lake States wood-using industries and public forestry agencies explored needs for future cooperative research in forest management. The first project suggested was a cooperative study of disking to stimulate aspen reproduction. The Station prepared a working plan, gave technical guidance, and in some cases furnished the disk for the several plots thus far established. It is hoped that the experiments will be completely installed during 1951. Industries provided the land, other equipment needed, and gave technical assistance.

One such study was installed in May 1950 by the Northern Paper Mills near Amasa, Michigan, in cooperation with the Station. An Athens Model C-4 disk, 6 feet wide, and a Caterpillar D-4 tractor were used in the tests. Four understocked aspen areas were disked in strips approximately 8 to 12 feet apart, center to center, at a cost of about $2.50 per acre. Units 1, 2, and 3 in the test are all on loamy sand, but Units 2 and 3 rate as better sites than Unit 1. Unit 4 is very rocky, soddy, and heavily grazed.

After one growing season the number of stems per acre was much greater on the disked than on the untreated area, as shown in the table below:

Comparison of Stocking on Disked and Undisked Areas

Unit	Disked[1]			Undisked (check)[2]	
	Area	Stems per acre	Quadrats stocked	Stems per acre	Quadrats stocked
	Acres	Number	Percent	Number	Percent
No. 1	10	6,125	70	1,600	50
No. 2	4	11,100	88	1,400	60
No. 3	6	11,600	90	4,000	80
No. 4	16	3,325	52	1,800	60

1/ 40 milacre quadrats of tally on each disked area.
2/ 10 milacre quadrats of tally adjacent to each disked area.

Units No. 2 and No. 3, on a favorable site, are most impressive with over 11,000 stems per acre and about 90-percent stocking. Unit No. 4 is so rocky and was so sparsely stocked originally that heavy root suckering could not be expected.

Reducing the Burden of Carrying Unproductive Deforested Land

Several million acres of nonrestocking deforested land are a liability to the region because they not only produce no wood but also require cash outlays for fire protection and other expenses. To guide the restoration of such lands to productive forest is the purpose of the Station's research in seed, nursery practice, and planting.

Sources of Good Jack Pine Seed

A large part of the area needing reforestation in the Lake States should be planted with jack pine. It is important, therefore, to know that the seed supply in old cones can be depended upon, as shown by a study initiated in northern Minnesota in 1935. Fifteen years after planting there were no real differences in development of trees grown from the seed of cones from one to 15 years old. Another phase of this problem will also be studied through a project in cooperation with the University of Minnesota and other public and private agencies. Plans have been made for a regional source-of-seed study on jack pine, and seed collections will begin in 1951.

Chemical Weed Control in Conifer Nurseries

Extensive experiments on weed control in conifer nurseries by spraying beds with mineral spirits have been conducted since 1947 at Hugo Sauer Nursery in Wisconsin, and they have resulted in such savings in labor that their use is now a standard nursery practice in most federal and state nurseries in the Lake States. In 1950 refinements were worked out as regards safe dosages for different weekly stages of first-year red pine. One fact discovered was that mineral spirits which have been stored for one or more years do more damage to trees than those freshly shipped in during the current year.

Methyl bromide, a toxic gas, applied as recommended by the manufacturers, reduced the number of weeds by seven-eighths 113 days after pre-germination treatment. Methyl bromide is toxic to tree as well as weed seeds, so seeding of the tree crop must be delayed at least one week after soil treatment.

Direct Seeding of Oak

As part of an oak management study, northern red oak acorns were sown in the spring of 1950 under an oak overstory on three typical sites in western Wisconsin. Results at the end of the first season were best (92 percent catch) under an open growth of brambles, intermediate (43 percent) under dense interrupted fern, and poorest (28 percent) on thin blue grass sod. Protecting seed spots with conical wire screens improved results by 25 percent.

A guide to Reforestation Practice

What to plant, when to plant, where to plant, how to plant, how to care for plantations, what enemies to guard against, and how to plan large-scale reforestation -- these are the main subjects covered in a comprehensive bulletin[2/] published during the year. It was based on

2/ "Forest Plantations in the Lake States" by Paul O. Rudolf. U.S.D.A. Tech. Bull. 1010, 171 pp., illus. August 1950.

20 years of research leavened with a large background of experience in forest planting in the Lake States. Information on direct seeding, conversion planting of aspen and brushlands, planting for wildlife food and shelter, and erosion control planting are also included.

Red Pine Plantations Respond to Release

Red pine plantations overtopped by aspen will lose much of their potential wood production if they are not released early, according to a study made by the Station on the Birch Lake Plantation near Ely, Minnesota. This 90-acre burn on the Superior National Forest was planted to red pine in 1915 and 1917. But aspen came in and by 1931 it had overtopped five-sixths of the plantation. At that time (15-17 years after planting), a large part of the aspen was cut. Plots were established in portions given different treatment. In 1949, or 18 years after treatment, measurements (given in the table below) showed that release was beneficial, even where delayed, but that it would have been much more effective if done earlier.

Treatment	Volume						Total stumpage value 1/
	1931			1949			
	Red pine	Aspen	Total	Red pine	Aspen	Total	
	Cords	Cords	Cords	Cords	Cords	Cords	Dollars
None	1.9	5.9	7.8	16.2	15.6	31.8	40.20
Moderate release	2.2	0.6	2.8	20.2	8.0	28.2	44.20
Full release	1.6	0.1	1.7	23.7	2.2	25.9	48.50
No release needed	1.9	...	1.9	32.9	0.3	33.2	65.95

1/ Based on red pine at $2 and aspen at $0.50 per cord.

In another study made in Lower Michigan, red pine plantations were released at 3, 10, and 30 years after planting. At the end of the first growing season there was not yet any response to release in height growth, but there was a definite relation between length of new needles and degree of release. It may require a period of time to build up the vigor of suppressed trees before actual growth increase becomes apparent.

FOREST FIRE RESEARCH

Good forestry can be practiced only if the forests are protected from fire and other enemies. Research at the Station during 1950 dealt largely with analysis of past fire records as a guide to more effective control methods.

1950 A Favorable Fire Season

The 1950 fire season in the Lake States was one of the most favorable on record from the standpoint of number of fires and area burned. Favorable weather conditions were largely responsible, but sound planning and prompt action on the part of both state and federal protection agencies contributed materially to the excellent record. Compared to the average for the last 10 years, there were only half as many fires and 15 percent as much area burned in 1950 on the Lake States national forests.

Spring and Late Summer the Worst Fire Seasons

Records for the last 10 years (1941-1950) from the national forests of the Lake States show that on the average fires are most numerous in April and May, and again in July and August, although some may occur in any month from March to December, as shown below:

Average Annual Cumulative Number and Percentages of Forest Fires on the National Forests of the Lake States, 1941-1950

Period ending	Average number	Percent of total	Minimum percent	Maximum percent
March 31	8.8	2.3	0.0	9.3
April 30	102.1	26.6	5.7	48.6
May 31	179.7	46.8	27.7	56.3
June 30	210.6	54.9	38.9	65.0
July 31	263.4	68.6	54.4	76.4
August 31	315.2	82.1	66.7	92.1
September 30	335.4	87.4	73.5	96.8
October 31	375.0	97.7	93.8	99.5
November 30	383.0	99.8	98.7	100.0
December 31	383.7	100.0	100.0	100.0

While the number of fires from year to year may vary considerably, most years follow the normal pattern with but nominal variation in the percent increase from month to month.

Forest Fire Control in Wisconsin

Effective forest fire control in Wisconsin dates from about 1930, although a system of Town Fire Wardens, under a State Forest Warden, was provided for as early as 1895 and a closed season on burning as far back as 1873. These early and inadequate efforts failed through lack of public support and interest. As late as 1920, for example, it was generally believed that all cut-over land would eventually be farmed and that forest fires were an aid to agricultural development. Aggressive protection efforts did not get under way until much of the original timber had been cut and the attempt of speculators to exploit submarginal land for farming had ended in failure. The protection of State forest land began about 1907 and was gradually extended to wild land adjoining. Protection districts outside the State forests, but under State supervision, were set up about 1925, and fire control began to develop in earnest. Today over 90 percent of the state is under organized protection, the average annual burn has been reduced from over 2 percent to less than two-tenths of 1 percent, and the size of the average fire from 200 to less than 10 acres. While occasional large fires still occur, protection in Wisconsin is, in general, adequate under any but emergency conditions. How much further the state is justified in going depends on the values at stake and the risk of loss. To provide a sound basis for judgment in this connection, the Station is cooperating with the State Conservation Department in assembling and analyzing past fire records.

Fuel Types Reclassified

An important consideration in fire protection planning is the determination of hazard or the burning characteristics of the forest fire fuels involved. The arbitrary designation of fuel types and their classification into fuel type classes on the basis of rate of spread and resistance to control that has been in effect since 1936 has proved useful but difficult to keep up to date. A start was made in 1950 to provide a simpler and more usable classification by relating hazard to cover type. The advantage of such a classification is that the forest type map, with the addition of slash areas, will also serve as a fuel type or hazard map and that the types in question are readily recognizable on the ground. It also simplifies the fuel type classification by reducing the number of fuel types and grouping them into a few broad classes on the basis of the average rate of spread prevailing under comparable burning conditions. The effect of burning index and wind velocity on rate of spread was also tentatively determined. Obviously the results obtained are empirical and do not give a specific evaluation of the factors involved. They do, however, provide a realistic appraisal of conditions for the guidance of field men in determining necessary action.

FARM FORESTRY

More than one-fourth of the commercial forest land of the Lake States is on farms. Much of it is of high potential productivity, but a great part of it has been neglected and is badly run down. A small but important part of the Station's research program, therefore, is aimed at discovering facts which will help farmers to manage their wood lots better and to utilize the products more wisely.

Demonstrating Wood-lot Management to Farmers

On experimental forests in northern Minnesota, northern Wisconsin, and the Upper Peninsula of Michigan the Station has set aside 40-acre tracts, typical of farm wood lots in these localities. These are called "farm-forestry forties" and are cut annually or biennially to remove the equivalent of the growth. Accurate records of costs and returns are kept, and the products cut are piled along a road on the tract. In cooperation with state extension foresters, field days, attended by as many as 150 to 250 farmers, then are held and the farmers are shown what has been done and what the results are. In an extension of this activity in Wisconsin, the Station cooperates with the Conservation Department and the extension forester on nine "Timber Harvest Forests," which are handled in a similar manner. One similar tract is being developed in Lower Michigan in cooperation with the Michigan Conservation Department.

For example, the fourth annual field day held on the Argonne farm forestry forty in northeastern Wisconsin in October 1950 was attended by 500 members of the American Forestry Association, as well as by local farmers. Decked in the forest were 5,300 board feet of logs, 4.1 cords of balsam fir and hemlock pulpwood, and 15 cords of hardwood fuel wood with a roadside value of $413.10. Deducting $131.99 for stumpage, and cost of horses, tractors, and power saws used in the operation, there was a net income of $281.11 for 183.5 man-hours of labor expended in the logging, or $1.53 per man-hour. If the farmer had owned the land, and in lieu of paying stumpage, had paid an annual tax of $12 on the 40-acre tract, his per-hour earnings would have been $1.83. These per-hour timber harvest earnings compare very favorably with earnings in other farming operations. The annual forestry income is a welcome addition to that obtained from agriculture and makes one of the strongest selling points for careful marking and logging of the farm's woodland.

Similarly, a 60-year-old mixed-oak stand in southwestern Wisconsin was thinned by removing about one-third of the basal area in undesirable trees. The farmer received a labor return of $1.25 per hour while improving this stand.

Five-year Returns from Farm Woodland

The last compartment on the farm woodland "forty" at the Upper Peninsula Experimental Forest in northern Michigan was logged in 1950. Since 1946 one compartment of 8 acres has been cut each year, removing from it the equivalent of the estimated annual growth for the entire 40-acre tract of northern hardwoods.

Products removed include sawlogs, chemical bolts, chemical cordwood, and pulpwood. The volume and proportion of these items have varied from compartment to compartment, but hourly returns have held up very well. Costs and returns for the area are summarized in the following table:

Hourly Returns from Farm Forty

Year	Roadside value of products	Skidding and other costs	Net return	Time worked	Returns per man-hour
	Dollars	Dollars	Dollars	Hours	Dollars
1946	313.73	59.40	254.33	208	1.22
1947	317.76	68.60	249.16	227	1.10
1948	323.87	27.00	296.87	220	1.35
1949	1/ 448.48	111.00	367.48	281	1.31
1950	1/ 490.65	108.33	382.32	251	1.52

1/ Delivered value. Hauling cost included with skidding and other costs.

The average hourly return from the five compartments involved is $1.31. Stumpage is not taken into account in the above figures, but would not have amounted to more than $32 in any given year. The whole project is set up from the point of view of a farmer or other small woodland owner doing his own logging during slack periods. The net returns constitute a substantial cash addition to his income from other sources.

Measured increment for five years, now available for Compartment One of this woodland, suggests that marking during the first cycle was conservative, removing somewhat less than the growth. Since cutting was confined to the poorest trees, the picture is really encouraging. Products worth nearly $2,000 were removed in five years. Yet, the stand has been improved and volume is now greater than it was before cutting commenced.

Growth of Oak Wood Lots

Well-stocked, unmanaged oak wood lots with about 5 M board feet per acre grow at a rate above 3 percent annually according to measurements made on growth plots in southern Michigan. Annual growth of the sawlog-sized trees in four different wood lots during a 10-year period ranged from 113 board feet to 221 board feet per acre on medium to good sites, with an average of 171 board feet. In addition, ingrowth in these particular stands ranged from 15 to 50 board feet with an average of 34 board feet per acre per year (International 1/4-inch rule). In similar wood lots, an improvement cut removing about 15 to 20 percent of the volume in undesirable trees increased board-foot growth for the ensuing 10 years by about 20 percent.

Driving Wooden Fence Posts Is Economical

A project to develop an economical fence post of native wood, begun in cooperation with the Minnesota Agricultural Experiment Station in 1948 showed how to save critically needed farm labor in 1950. Studies conducted at the University of Minnesota Branch Stations at Rosemount and Waseca indicate that the average farmer using hand methods for digging holes and tamping the posts can set about 4 posts per hour in new fences. Using a power post driver, this same man can set or drive 15 posts each hour. Not only does the power driving of wooden posts save nearly three-fourths of the manpower needed for hand setting, but the work is much easier and the driven wooden posts are more firmly set in the ground.

Applying this labor requirement data to the annual requirement of 15,000,000 fence posts for Minnesota, labor savings up to one-third million man-days could be realized by driving wooden posts, as shown below:

Operation	Posts set per man-hour of labor	Estimated time to set posts in Minnesota (annually)
	Number	Man-days
Hand digging and hand tamping - wooden posts	4	468,750
Power digging and hand tamping - wooden posts	5	375,000
Hand driving - steel posts	13	144,231
Power driving - wooden posts	15	125,000

The labor saved by power driving as compared to hand setting would be adequate, given proper farming machinery, to grow corn on more than 400,000 acres, the equivalent of 8 percent of the average Minnesota corn crop. The power post driver not only makes possible this large saving in farm fencing labor costs, but it also places the treated wooden post in the forefront as an economical fence post. In this way it provides a profitable market for small trees which should be cut to thin young pine stands, and thus makes possible better forest management. It also would make possible a saving of steel which can be used for products more vital than fence posts.

FOREST WILDLIFE RESEARCH

(Conducted by the Fish and Wildlife Service in cooperation with the Forest Service)

Forest wildlife is of interest from two aspects: (1) as a crop of the land, and (2) as a deterrent to tree growth. Study of both has been made, but emphasis at the Station has been on the latter.

Ecological Study of the Moose on Isle Royale National Park (Michigan)

Observations on 1,238 sample plots in May and June 1950 made it clear that the moose browse supply on Isle Royale is still critical but that there has been some improvement since the 1948 investigation. The 12 top-ranking foods in 1950 were: paper birch, aspen, redosier dogwood, willow, mountain-ash, balsam fir, sugar maple, juneberry, American green alder, mountain maple, cherry, and highbush cranberry. They formed 97 percent of the food eaten, and 8 of them were excessively browsed. The die-off of moose referred to last year continued into 1950. In the course of the study there were found 19 moose that had died during the winter of 1948-1949, and 8 more that had succumbed during the winter of 1949-1950. The decline in moose population was no doubt responsible for the slight improvement noted in the winter range.

Deer Range Examinations

A study of 676 deer browse plots on the Necedah National Wildlife Refuge in central Wisconsin made in March 1950 showed that 21 plants were used but that the following 5 formed 93 percent of the food eaten: willow (29), aspen (25), jack pine (22), oak (10), and juneberry (7). Annual hunting seasons since 1946 (1945 for bow and arrow only) have reduced the herd to a point which the present range will carry. The population should not be permitted to increase beyond its present level until browse conditions indicate that the range can support a larger herd. The index of browsing was low for all species since it ranged from .3 percent for dewberry to 11.3 percent for willow. For the refuge as a whole, the volume of browse was very low and this is due in part to past heavy browsing and to the poor, sandy soil.

A similar study of 505 sample plots made on the Tamarac National Wildlife Refuge in Minnesota showed that deer browsed 30 species of plants during the winter, but that 10 formed 86 percent of the diet, while 5 made up 74 percent. The percentages consumed, by species, were as follows: hazel, 37; redosier dogwood, 13; cherry, 11; willow, 10; bur oak, 3; red oak, 3; black ash, 3; basswood, 2; balsam fir, 2; and paper birch, 2. Six of the 10 species listed were severely browsed. Much of the browsing was old, and old browse lines were noticeable on jack pine and on balsam fir in the swamp areas. The bulk of the food supply now is made up of hazel, a rather poor browse species. Although the area once supported a higher deer population, the present range will not support such a population without losses from starvation.

Deer Exclosures

A method of recording vegetation has been devised and a study has been started on 12 deer exclosures located on the Chippewa and Superior National Forests in Minnesota and on the Lower Michigan National Forest. Findings will be summarized in future annual reports.

An Appraisal of Porcupine Damage in Second-growth Northern Hardwoods

A survey of porcupine damage in second-growth northern hardwoods made on the Argonne Experimental Forest in northeastern Wisconsin showed that of 828 commercially valuable trees over 4.6 inches d.b.h., 9.1 percent were severely damaged and another 9.2 percent slightly damaged. The loss on the 60-acre tract was estimated at 5.2 percent of the annual growth with an 8.3 percent reduction in potential stumpage value. This represents a loss of 9.4 board feet, or 20.8 cents per acre per year -- often equal or greater than the annual taxes on forest land of this nature. Intensive hunting on the experimental area resulted in a kill of one porcupine for every 6-2/3 acres.

Damage to Natural Reproduction by Deer Browsing

That an uncontrolled deer herd does serious damage to forest reproduction in the northern hardwood-hemlock forests and mixed swamp forests was shown by a survey of the Argonne Experimental Forest, a large part of which was within a wildlife refuge prior to the fall of 1949. Before any hunting was permitted on this area, an examination was made of 648 fifth-acre plots mechanically spaced over 1,880 acres; 96.4 percent of them showed heavy damage to the available reproduction. This damage was especially severe in the hardwood and hemlock-hardwood types where light selective cuts were made 10 to 15 years previously. Openings in the stands caused by logging had almost completely failed to restock satisfactorily. Although there were many thousand young trees per acre in these openings, they had been browsed back to the snow line annually.

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PERSONNEL

LAKE STATES FOREST EXPERIMENT STATION

As of December 31, 1950

Administration - Elwood L. Demmon, Director
Jerry Roch, Administrative Officer
Charlotte L. Devine, Clerk
Helen A. Woodworth, Clerk-Stenographer
Dorothy A. Keller, Clerk
Mary H. Seaman, Clerk
Adele M. Gibney, Clerk-stenographer
M. Evelyn Wright, Stenographer

Forest Management - Francis H. Eyre, Forester, In Charge
Paul O. Rudolf, Forester
Suren R. Gevorkiantz, Forester
Lucille P. Olsen, Statistician
John R. Neetzel, Forester (Farm Forestry, in cooperation with the University of Minnesota)

Field Stations

Headwaters Forest Research Center, Grand Rapids, Minnesota
Lawrence P. Neff, Forester, In Charge
Zigmond A. Zasada, Forester
Eugene I. Roe, Forester
Robert A. Ralston, Forester
Lee S. South, Forestry Aide
Archie V. English, Clerk

Northern Lakes Forest Research Center, Rhinelander, Wisconsin
Joseph H. Stoeckeler, Forester, In Charge
Carl Arbogast, Jr., Forester
Miron L. Heinselman, Forester
H. F. Scholz, Forester (Effective 11/3/50)
Edward R. Stoltz, Clerk

Lower Peninsula Forest Research Center, East Lansing, Michigan
John L. Arend, Forester, In Charge
LaMont G. Engle, Forester
Leslie W. Gysel, Forester (5/1-6/30)
James J. Kellis, Clerk

Upper Peninsula Forest Research Center, Marquette, Michigan
Walter M. Zillgitt, Forester, In Charge
Franklin R. Longwood, Forester
Wilho A. Salminen, Forestry Aide
Gloria D. Matson, Clerk.